Relating and Visualising CSP, VCR and Structural Traces

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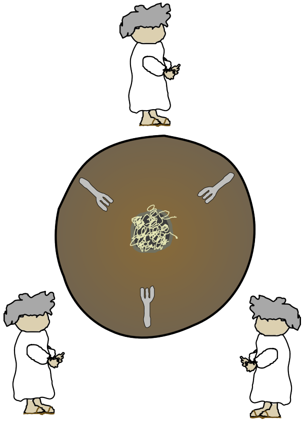
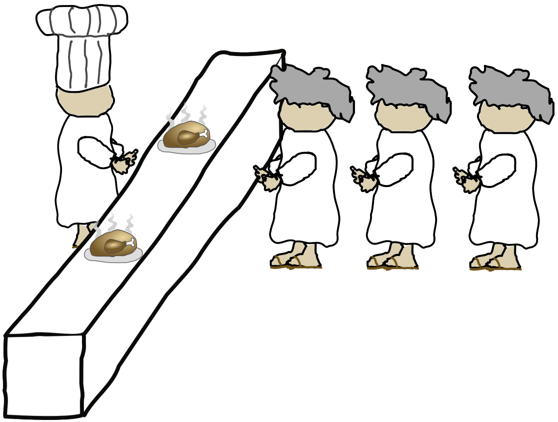
2 November 2009

Dining Philosophers



Starving ~~Dining~~ Philosophers



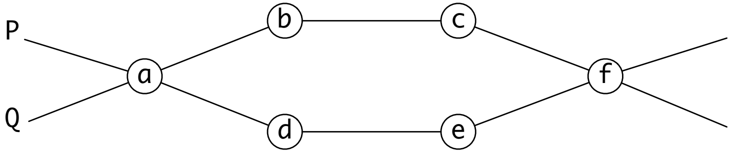
Visualization: Strings and Beads

Consider the CSP system:

$$P \underset{\{a,f\}}{||} Q$$

where

$$P = a \rightarrow b \rightarrow c \rightarrow f \rightarrow \text{SKIP}$$
$$Q = a \rightarrow d \rightarrow e \rightarrow f \rightarrow \text{SKIP}$$



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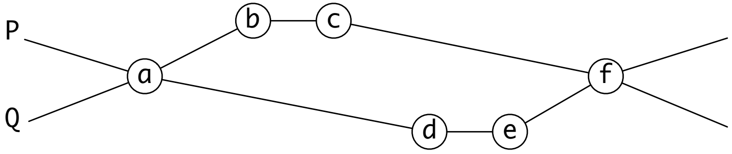

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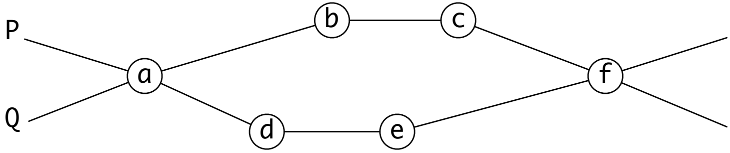

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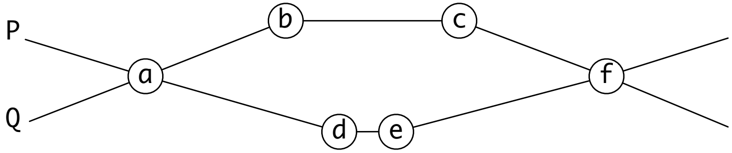
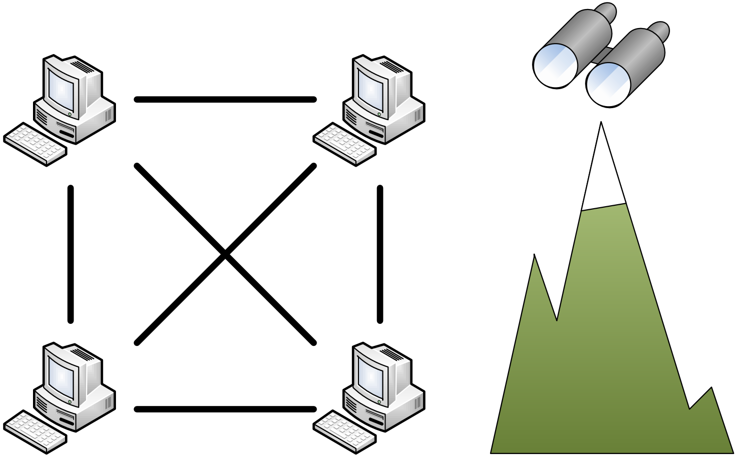


CSP Observer



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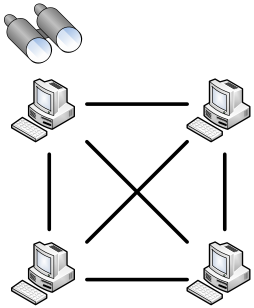

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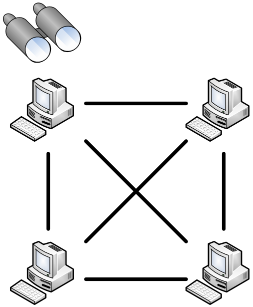

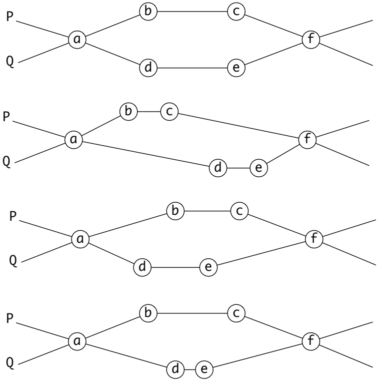

$\langle a, b, c, d, e, f \rangle$ $\langle a, b, d, c, e, f \rangle$ $\langle a, b, d, e, c, f \rangle$

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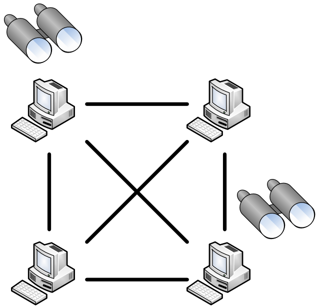
VCR Observer(s)



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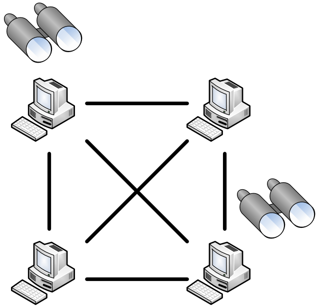

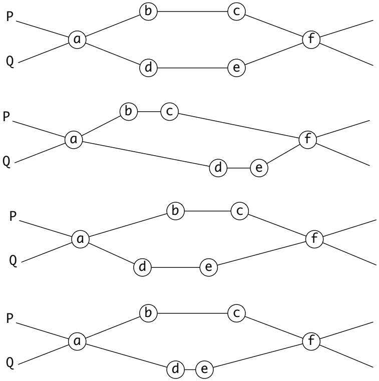

$$\langle \{a\}, \{b, d\}, \{c, e\}, \{f\} \rangle \qquad \langle \{a\}, \{b\}, \{c, d\}, \{e\}, \{f\} \rangle$$

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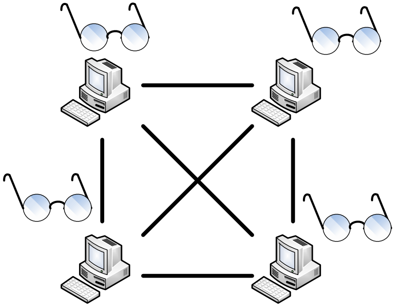
Structural Observers



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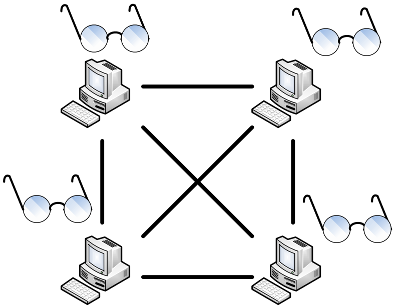
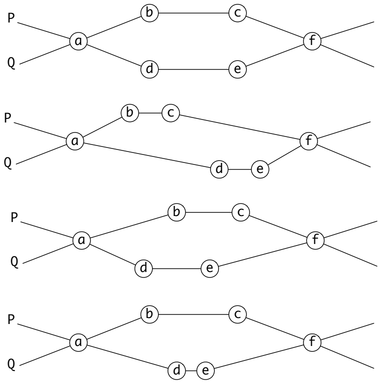




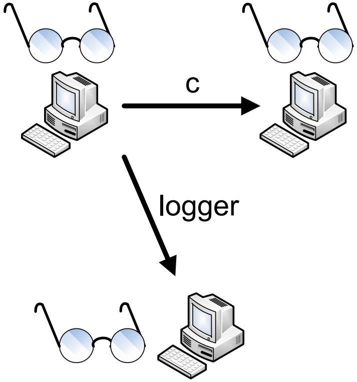
$$(a \rightarrow b \rightarrow c \rightarrow f) \parallel (a \rightarrow d \rightarrow e \rightarrow f)$$

Traces

Three types of traces:

1. CSP traces
   - A sequence of individual events, recorded by the observer; events observed simultaneously are interleaved
   - abstracts away time and space
2. VCR Traces
   - A sequence of event multisets; multiple observers account for different views
   - preserves time independence; abstracts away space
3. Structural Traces
   - Sequential and parallel composition of the trace reflects the program's structure
   - preserves time independence and space

Space and Mobility



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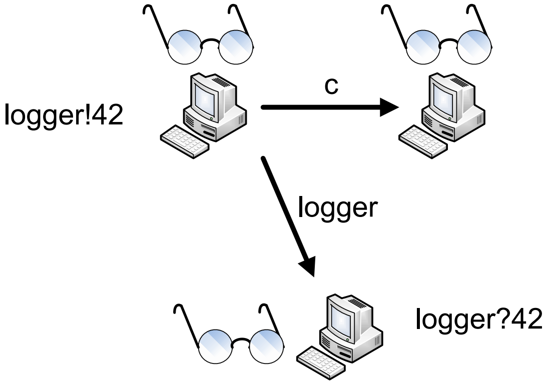

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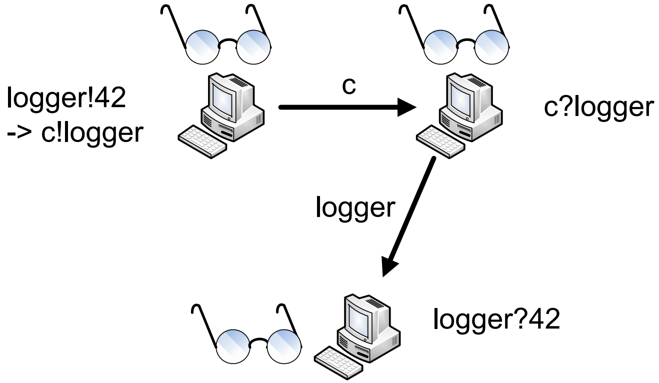

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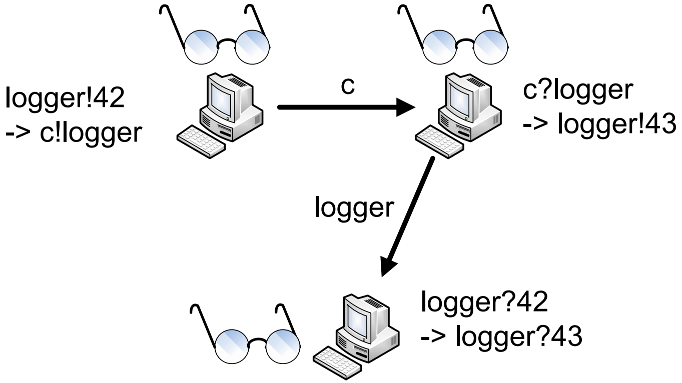

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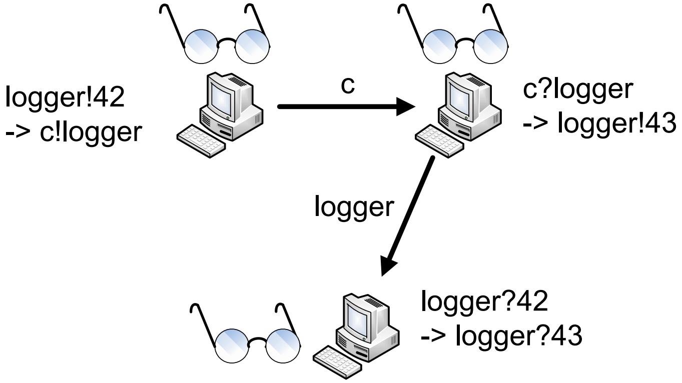

$$(\mathit{logger}!42 \rightarrow \mathit{c}!\mathit{logger}) \mid\mid (\mathit{c}?\mathit{logger} \rightarrow \mathit{logger}!43)$$
$$\mid\mid (\mathit{logger}?42 \rightarrow \mathit{logger}?43)$$

Conversion Example

CSP:

$$P = (AB \mathbin{;} AB) \underset{\{b\}}{||} (b \rightarrow b \rightarrow \text{SKIP})$$

$$\text{where } AB = (a \rightarrow \text{SKIP}) \mathbin{|||} (b \rightarrow \text{SKIP})$$

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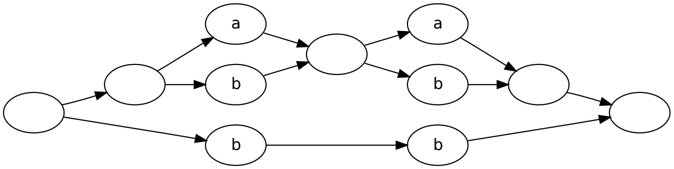
Structural Trace Visualisation:



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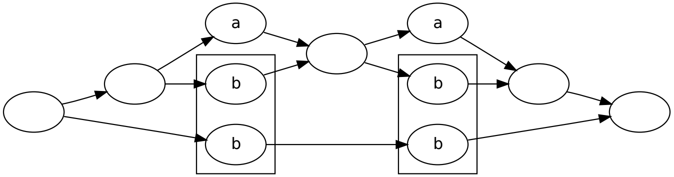
Structural Trace Conversion Algorithm:



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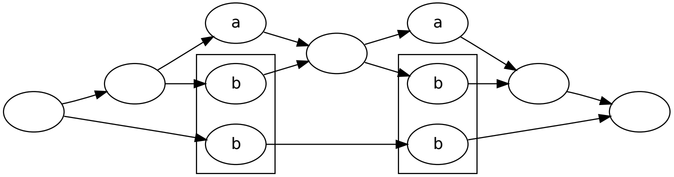
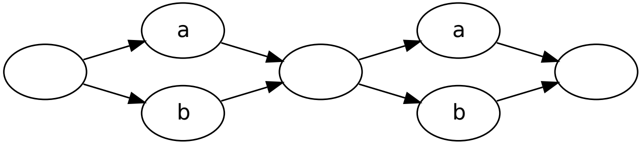


VCR Trace Visualisation:



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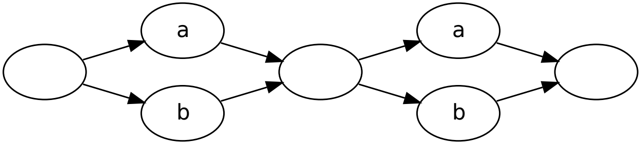

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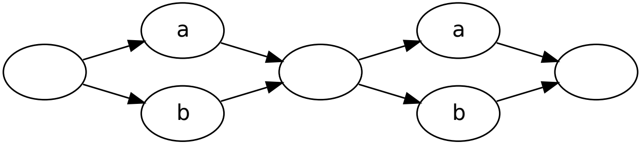
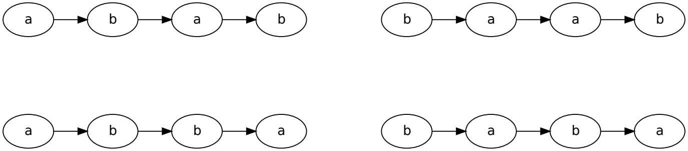
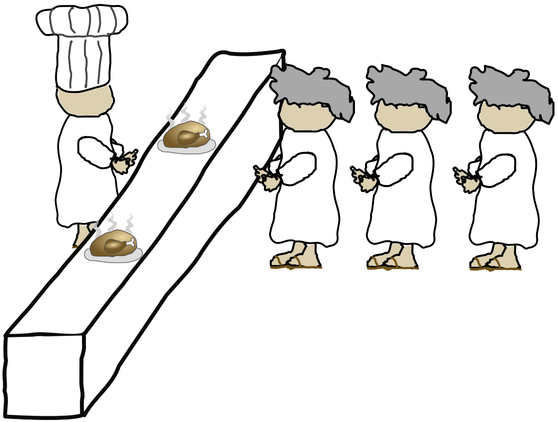


CSP Trace Visualisation:



Starving CHP Philosophers



Starving CHP Philosophers Trace

```
philosopher eatChicken = forever (syncBarrier eatChicken)

chef a b c = forever  ((syncBarrier a <&> syncBarrier b)
                      <-> (syncBarrier b <&> syncBarrier c)
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```

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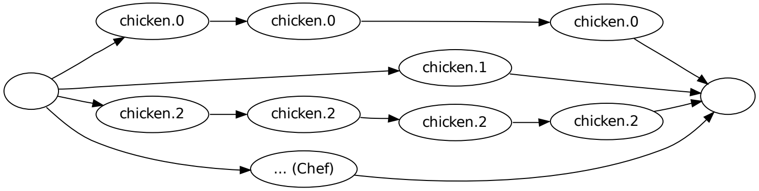
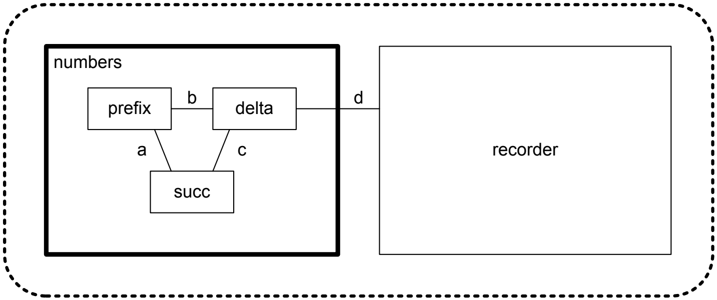


Summary

- Traces are useful for diagnostics and observing run-time behaviour
- Structural traces
  - Most straightforward and efficient to record
  - Useful for observing mobility
- Conversion algorithms
  - One Structural trace converts to many VCR traces
  - One VCR trace converts to many CSP traces
- Visualisation
  - Graphs to represent CSP, VCR and Structural traces
  - Tool support will be beneficial

Tools to Explore Traces



42*(b? -> (c! || d!))
||
(42*(b! -> a?) -> b!)
||
42*(c! -> a?)

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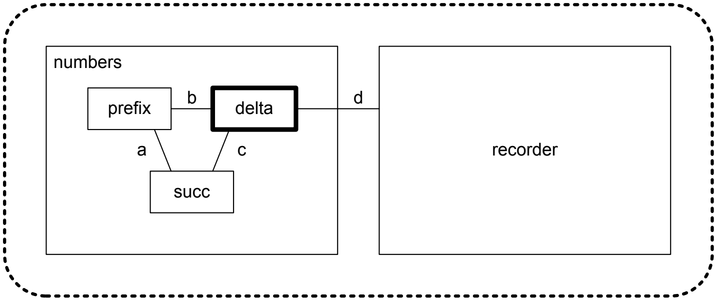

42*(b? -> (c! || d!))

Challenge: Structural traces and UTP

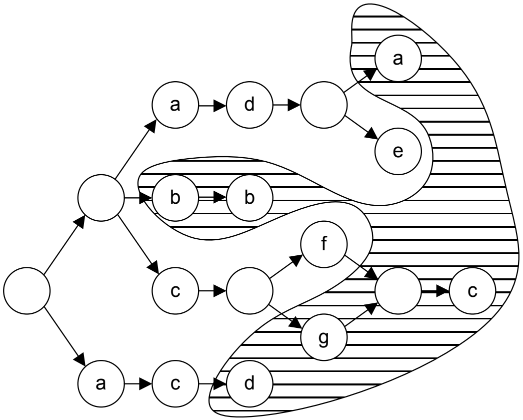

Figure: Concatenation, quotient and healthiness conditions

Questions?

- Practical demo of traces for testing – tonight at the fringe